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MAJOR MAINTENANCE ADDERS PLAN

Potomac Economics, Ltd.
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This document presents an approach proposed by Potomac Economics to quantify Major Maintenance Adders for use in calculating Default Energy Bids (DEBS). Following a presentation of the economic theory behind using the adders, presented below is a description of the data collection phase followed by the production phase of the approach.

I. Economic Theory for Adders

In a competitive market, suppliers will submit offers at prices that reflect the marginal costs of supplying the product, i.e., the incremental costs of supplying the product. Therefore, market rules in wholesale electricity markets designed to mitigate market power must allow generators to reflect all costs that are marginal to the decision to start and run generating units. Certain types of "major maintenance" costs are incurred infrequently and may appear to be fixed costs (and not marginal costs). However, the frequency is directly correlated with starting the unit and/or running the unit for a period of time after the unit has started. Therefore, the major maintenance costs are marginal costs with respect to starting or running the unit.

For example, a unit that should undergo a major overhaul after a specified number of starts or run hours would rationally cause the supplier to consider these costs in its decision to start and run the unit. Depending upon how the incurrence of the major maintenance expense is affected by each of these factors, the marginal cost components associated with major maintenance may be accurately quantified in a $ per run-hour, a $ per start, and/or $ per MWhr cost component.[1] The purpose of the approach described in this plan is to gather the necessary information and produce marginal cost adders to reflect major maintenance for each generating unit.

II. Major Maintenance Data Collection

Establishing of Major Maintenance Adders will require the collection of a significant amount of information and data from CAISO and its participants.

Potomac Economics will first work with CAISO to develop criteria to identify major maintenance costs and differentiate them from other costs. The criteria will capture large expenditures that occur infrequently and whose frequency is a direct result of unit starts, run

[1] Marginal cost that are driven by energy production ($/MWhr) use the existing DEB process to capture major maintenance in the incremental energy curve.

hours or energy production. The definition will exclude costs that do not vary with the operation of the unit (fixed costs).

Data on the major maintenance expenses will be collected through a standard template for each unit. The template is expected to be spreadsheet based with validation to ensure it is completed properly. The template will collect the following types of data:

- Identification of individual major maintenance items (cost elements);
- A forecast of the cost for each major maintenance item;[2]
- The schedule for each major maintenance item, including which operating parameters drive the schedule;
- Historic costs for each major maintenance item;
- When each maintenance item was last completed or other information that identifies the current position of the generating unit within the maintenance cycle;
- Supporting documentation to the templates
  - Long Term Service Agreements ("LTSA"). For some units, major maintenance is predefined based on Original Equipment Manufacturers ("OEM") recommendations and contractually assigned to a service provider through LTSAs.
  - Generation owners can supply other supporting documentation that would be relevant to establishing major maintenance adders

Potomac Economics will validate the information submitted by comparing it to the historic experience for the unit and by comparing it to other similar units based on technology, size, and age. For resource whose major maintenance is conducted under an LTSA, we will ensure consistency of the costs with the LTSA and monitor the LTSAs to ensure that they are not used to inflate the major maintenance adders.

For each cost item and schedule, Potomac Economics will translate cost into real present-day dollars and use this cost to calculate the individual components of the Major Maintenance Adders.

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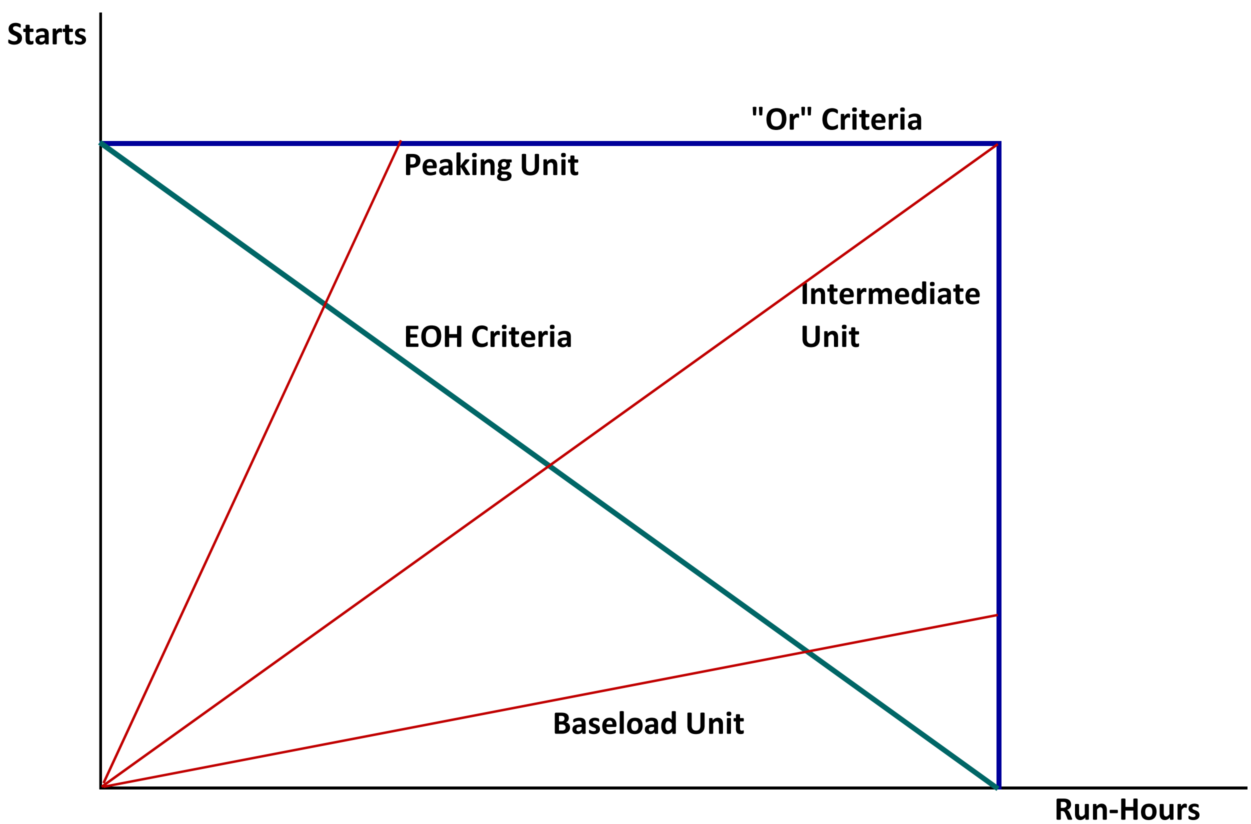
[2] All costs will need to indicate the year $ they are reported in, which will enable us to properly account for inflation.

III. Produce Major Maintenance Adders

Potomac Economics will gather historic operating data that can be used to develop an expectation of how each unit is likely to operate by season. This data will include a time series of starts and run hours for each generating unit. Based on the expected run-hours per start and the major maintenance schedule and costs provided by the supplier, Potomac Economics will produce optimal distributions of costs to various adders.

The operating parameter to assign major maintenance to depends on the maintenance schedule and the operating profile of the resource. Maintenance schedules can vary significantly, which affects how the adders would be produced. This is illustrated in the following figure, which shows two types of maintenance schedules. The first schedule shown by the blue square is an example of where major maintenance is needed based on the sooner of a maximum number of starts or a maximum number of run hours (referred in the figure as the “or” criteria). Alternatively, some manufacturers recommend major maintenance based on the number of starts and run-hours where each start is equivalent to a certain number of run-hours (i.e., the Equivalent Operating Hour (EOH) method). This is shown by the green line in the figure.



"Or" Criteria

Under the Or Criteria, the start criteria or the run-hour criteria may be binding for a unit depending on its average run-hours per start. The three red lines in the figure show three types of units. The units have different operating profiles and, therefore, intersect the "Or" criteria at very different locations. For example, the top line shows a peaking resource that typically has a low number of run-hours per start (because their incremental energy costs are relatively high). For the peaking resource, the maintenance intervals are determined only based on the number of starts, so the maintenance adders should be applied to the starts. The starts are limiting for peaking resources because the failure mechanisms that are expected to limit the life of the equipment are based on thermal cyclic fatigue, which leads to crack propagation in hot gas path parts. Each start creates an additional thermal cycle.

However, baseload resources (i.e. run hours per start are large), the maintenance intervals are primarily determined based on the run hours, so the maintenance adders should primarily be applied to the run hours. The run hours are limiting for baseload resources because the failure mechanisms that are expected to limit the life of the equipment are based on the run-time dependent conditions of creep, oxidation, and corrosion.

In some cases, the distribution of the maintenance adders based on the operating profile can cause the operating profile to change. For example, for a unit has been operating with a relatively low level of run-hours per start (like the peaking resource above), shifting the allocation of the adders from run hours to the start-up cost would raise the unit's start-up cost and lower its minimum generation cost, which will tend to increase the unit's average run-hours per start. This could shift the operating profile toward the line shown in the figure for the intermediate unit. The advantage of this shift is that it will increase the utilization of the unit under the major maintenance schedule.

If the allocation of the maintenance adders is seen to affect the operating profile of the resource, it is rational divide the adders between the starts and the run hours and adjust the allocation on an ongoing basis based on the operating data for the resource.

EOH Criteria

Under the EOH criteria, the adders would be divided between start-up cost and minimum generation cost in the same ratio as the EOH criteria. For example, if one start is equivalent to 20 run-hours, the major maintenance cost would be divided by the total run-hour in the maintenance cycle to establish the minimum generation cost adder while the startup-cost adder would equal the minimum generation adder times 20.

Automated Updates Based on Operating Data

Depending on the starts and run hours per year, a unit would typically have time between major maintenance intervals ranging from one to four or more years. Over these years, the trajectory of run hours per start will likely vary by season given a constant set of maintenance adders. For example, a unit is likely to have a longer average number of run hours per start in the summer than in the spring.

For cost elements that are incurred based on the Or Criteria, we will develop expected operating profiles by season and compare the actual operating data to these expectations to determine whether each major maintenance costs should be allocated to starts or minimum generation. Because the operating profile may change over time, the allocation of the adders between starts and minimum generation will be updated on a monthly basis.

Additionally, market participants may contact Potomac Economics when a significant issue arises that may change the amount or allocation of the major maintenance adders. Such issues will be specified in the CAISO rules, but should include the expiration LTSA or significant changes in the physical condition of the generator that affects the major maintenance costs or schedule.